

ANALYSIS OF STUDENTS' DIFFICULTIES IN SOLVING ALGEBRA PROBLEMS AND ITS IMPLICATIONS FOR UNDERSTANDING MATRIXES

Muhammad Permadi¹, Atin Risnawati²
Sekolah Tinggi Agama Islam Kuningan¹
Sekolah Tinggi Agama Islam Kuningan²
muhammadpermadina@gmail.com¹
atinrisnawati@gmail.com²

Keywords	Abstract
<i>algebraic difficulties, matrix understanding, mathematics education students</i>	<i>This study aims to analyze the challenges faced by students in solving algebra problems and how these challenges affect their understanding of matrix material. The study was conducted at IAIN Kerinci using a qualitative case study approach. Data were collected through evaluation and interviews with three students who were selected purposively based on the level of difficulty shown in solving algebra problems. The results of the study indicate that difficulties in algebra, especially in basic operations, factoring, and elimination and substitution methods, have a direct impact on students' understanding in solving matrix problems. There are differences in ability between students who are strong in algebra but weak in matrices, and vice versa. Difficulty in transferring knowledge from algebra to the matrix context is also a major obstacle. This study provides important implications for learning design, namely the need for explicit integration between algebra and matrix concepts through contextual and participatory learning models</i>

Corresponding Author: Nama author
E-mail: (Times New Roman (Body), Font Size 10)



INTRODUCTION

A good understanding of mathematics is essential in a student's academic life, especially in the context of algebra and matrices. However, many students have difficulty solving algebra problems, which has direct implications for understanding advanced mathematical concepts such as matrices. (Klorina & Prabawanto, 2023) . This difficulty is often caused by a lack of mastery of basic algebraic operations, factoring, and methods for solving linear equations in one variable, all of which are the basis for understanding matrix material (Alamsyah, 2017) . Algebra is one of the subjects that requires in-depth understanding because each concept in algebra forms the foundation for more complex material (Sulasteri et al., 2019) . Ineffective learning and inappropriate application of concepts can cause students to have difficulty understanding more advanced material, such as matrices (Azzahra et al., 2024) . This problem must be resolved immediately, because otherwise it will affect the quality of learning and students' mastery of mathematics in the long term.

The main cause of students' difficulties in solving algebra problems is the lack of sufficient practice in problem solving and a lack of understanding of the basic concepts of algebra (Wasito & Kurniawan, 2018) . Many students tend to memorize formulas without really understanding how to apply them in the context of more complex problems (Asri et al., 2024) . This is exacerbated by a teaching style that does not provide space for students to practice and explore the material in depth. For example, in factoring problems or elimination and substitution methods, students tend to ignore the correct calculation steps and immediately look for quick answers without understanding the basis of each step. In fact, a deep understanding of algebraic procedures is very important, because if this basis is not mastered properly, students will have difficulty understanding more complicated advanced material, such as matrices (Hasibuan, 2014) .

The consequences of the difficulty in solving these algebra problems have a significant impact on students' understanding of matrix material. Mathematics is an interconnected science, and when one concept is not well understood, chain consequences will occur in more advanced material (Radiusman, 2020). In matrix learning, basic operations such as matrix addition and multiplication, as well as matrix transformations, are highly dependent on a good understanding of algebraic concepts (Pratama et al., 2024). Without sufficient mastery of algebra, students will have difficulty understanding these operations and may have difficulty solving problems related to matrices (Hermanto & Susulawati, 2023). If this phenomenon is allowed to continue, the quality of mathematics education will continue to decline, and students will have greater difficulty in achieving the desired competencies in this field.

To overcome this problem, one solution that can be applied is to use a problem-based learning model or problem-based learning (PBL) which emphasizes the application of mathematical concepts in real-life contexts and problem solving (Pratiwi & Mawardi, 2022). This learning model provides students with the opportunity to identify and solve relevant problems, as well as understand the importance of theoretical basis in practical application. PBL allows students to actively participate in the learning process, which will deepen their understanding of the basic concepts of algebra which will later support the mastery of matrix material. (Putria & T, 2024). With this approach, students can more easily connect between algebraic concepts and their applications in more complex materials (Manurung et al., 2024). This solution was chosen because it has proven effective in improving students' understanding of mathematical concepts and improving their problem-solving abilities, as evidenced by various previous studies (Paillin et al., 2024).

In addition, another solution is to provide additional materials in the form of tutorials or intensive mentoring to students who have difficulty understanding algebra. Mentoring programs like this can help students understand the steps in solving algebra problems, from the most basic to applications in more complex contexts (Yulianti, 2018). This approach was chosen because it can provide direct support to students who need extra help, so that they can understand and overcome the difficulties they face more effectively. This mentoring program also provides space for students to ask more questions about the difficulties they face, which cannot always be covered in larger regular classes (Purnamasari & Setiawan, 2019).

This research is important to do because the difficulty in understanding algebra and its implications for understanding matrices is a problem that is often faced by students in learning mathematics. With this research, it is hoped that effective solutions must be found to improve students' understanding of algebra and matrices, which will ultimately improve the quality of mathematics education as a whole. This research can also provide deeper insight into the factors that influence the difficulties faced by students in understanding algebra, as well as provide recommendations for the development of more effective curricula and teaching methods (Rahim & Jainuddin, 2025). Therefore, this research is not only important for the development of mathematics education, but also for the development of students' academic quality in general.

Research on students' difficulties in solving algebra problems that have implications for understanding matrices has been widely conducted from various perspectives. The first study by (Riastuti et al., 2023) showed that students experienced many obstacles in solving linear algebra problems, especially in basic operations, which had a direct impact on their weak understanding of the concept of matrices. The second study was conducted (Kurniawati et al., 2019), which analyzed the impact of implementing a problem-based learning (PBL) model on improving understanding of algebra and matrices. However, the main focus of this study was on the effectiveness of the learning method, not on identifying students' specific difficulties in solving algebra problems and how it affects their understanding of matrix material. The third study by (Gustianingrum & Kartini, 2021) revealed a significant relationship between mastery of algebraic concepts and learning outcomes on the topic of

matrices. They found that understanding algebra greatly influenced students' success in solving matrix problems, especially those related to basic operations and matrix inverses. The fourth study conducted by (Rangkuti, 2022) examined various challenges in learning mathematics in higher education, including difficulties in understanding algebra. He highlighted that symbolic abstraction in algebra is often a major obstacle for students, which then has an impact on their understanding of other mathematical materials such as matrices. Another relevant study is the study by (Nurhaliza et al., 2020) which focuses on the effectiveness of problem-based learning models in improving students' algebra problem-solving abilities showing an increase in critical thinking skills and active participation in solving problems. This study does not explicitly state it with an understanding of the matrix concept. This study has a novelty by deeply analyzing the types of difficulties faced by students in solving algebra problems and directly imposing these difficulties on their understanding of matrix material. Unlike previous dominant studies, this study uses a qualitative approach to explore students' thinking processes and contextual errors more thoroughly. In addition, this study also considers the pedagogical implications of the findings obtained to make a direct contribution to the development of mathematics learning strategies in higher education. Thus, this study not only explains the relationship between two mathematical concepts, but also explores the causes and impacts of the difficulties faced by students in real learning contexts

METHOD

This study adopts a qualitative approach with the aim of understanding in depth the experiences and thought processes of students when solving algebra problems and their impact on their understanding of the concept of matrices in second semester students at IAIN Kerinci. This approach allows researchers to explore the meaning formed by individuals in a natural context, in accordance with the view of (Waruwu, 2023)) which emphasizes that a qualitative approach is suitable for exploring subjective experiences in complex situations. Thus, this study focuses more on the process, not just the results, thus producing in-depth and holistic data regarding the problems faced by students. The method applied is a case study, which aims to analyze certain phenomena in a real context comprehensively. According to (Ilhami et al., 2024) , case studies are suitable for use when researchers want to understand the in-depth details of an event or process. In the context of this study, the focus of the case study is directed at helping students solve algebra problems and their impact on understanding matrix material. The data collection methods applied in this study are test questions, interview guidelines, and observation sheets.

The population in this study consisted of several IAIN Kerinci Mathematics Education students who had taken courses on algebra and matrices. To determine the respondents, a purposive sampling technique was used, in which three students were selected based on the results of the algebra test questions. These three subjects showed the highest level of difficulty and variation in the types of errors made, so they were considered to be able to provide the most relevant and in-depth data. (Subhaktiyasa, 2024) explains that in qualitative research, selecting informative subjects is more important than large numbers, because the main goal is the depth of analysis. The three respondents were then further analyzed through interviews and observations to understand the background of the difficulties they experienced. They represent variations in terms of problem-solving strategies, conceptual understanding, and common types of errors. This strategy allows researchers to identify patterns of difficulty and relate them to obstacles in understanding the concept of matrices, so that strong conclusions can be drawn regarding the pedagogical implications of the findings

RESULTS AND DISCUSSION

This study aims to identify various forms of difficulties faced by students in solving algebra problems and understand their impact on matrix problems. Data collection was carried out using two methods, namely tests and in-depth interviews. The test was given to ten students to identify the difficulties that arise when solving problems related to algebra and matrices. From these results, three students were selected as the main research subjects using purposive sampling techniques. This third subject was chosen because it reflects different error patterns and represents a variation in the level of difficulty that is relevant to the focus of the study. To improve understanding of the difficulties they face, interviews were conducted with students to explore aspects of concepts and procedures in solving problems.

The following are the results of tests and interviews conducted on three students.

1. Test and interview results for students subject 1 LF

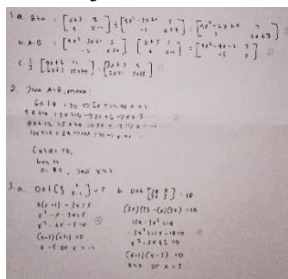


Figure 1. Results of answers to LF matrix questions

Based on the results of the analysis of the test and interviews with LF students, it shows that LF has a fairly good ability in solving problems related to matrix material. He is able to understand the basic concept of matrices and can work on several problems correctly, especially problems related to simplifying matrix forms, determining values in matrix form and factoring in matrix determinants. In working on test problems, LF shows an understanding of the matrix structure and is able to apply calculation procedures that are appropriate to several types of problems on matrix material.

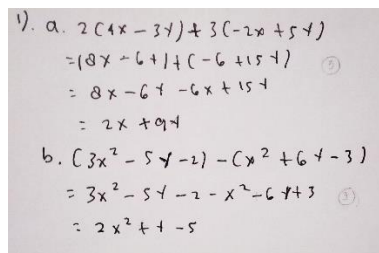


Figure 2. Results of answers to LF algebra questions

On the other hand, unlike his ability in matrix material, LF experienced quite significant difficulties in solving algebra problems. One of the most obvious difficulties was in factoring algebraic forms. LF did not seem to have mastered the basic techniques of factorization, so he had difficulty in simplifying and rearranging the given algebraic forms. In addition, LF was also unable to determine the value of variables in one-variable algebra problems, while in the context of matrices, he was able to solve the problems in a structured manner. Another problem faced by LF was in problems that used the elimination and substitution methods. In both algebraic and matrix materials, LF experienced confusion and was unable to solve the questions. This shows that although LF can understand some aspects of the matrix material, his lack of mastery of the basics of algebra, especially in terms of factorization and understanding of linear equation systems, hinders his ability to solve problems that require integration between the two materials. This was also found in LF's test results and was also explained during interviews with LF students.

2. Test and interview results for students of subject 2 NN

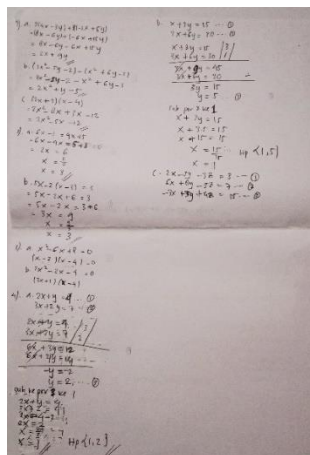


Figure 3. Results of answers to NN algebra questions

The results of tests and interviews conducted on subject NN showed that he had a fairly good understanding in solving algebra problems. NN is able to solve various forms of algebra problems, such as simplifying algebraic forms, determining variable values, and doing factoring, with systematic steps and correct results. This shows that NN has mastered the basic concepts of algebra well and is able to apply them consistently to the various types of questions given.

However, NN experienced quite serious difficulties when faced with problems related to matrix material. When asked to solve problems that have a form and procedure similar to algebra problems, but presented in the context of matrices, NN seemed unable to answer them. For example, in problems of simplifying forms in matrices such as addition, subtraction, and also multiplication, he was unable to solve them, even though he had previously succeeded in solving algebraic simplification problems correctly. Likewise, when asked to determine the value of a variable in matrix form, NN was unable to answer it, even though he could effectively solve it in algebraic form. The same thing also applies to factoring problems, even though NN understands factorization techniques in algebra, he cannot apply them in the form of matrix problems.

In addition, NN also had difficulty when working on problems that used the elimination and substitution methods in the context of matrices. In fact, in algebra problems that used the same method, NN was able to solve them correctly. This condition shows that NN still experiences obstacles in applying the understanding of algebraic concepts into matrix form. This difference is an indicator that although mastery of algebraic concepts is quite good, a deeper understanding of how the concept is applied in the context of matrices is still needed.

3. Test and interview results for students of subject 3 MF

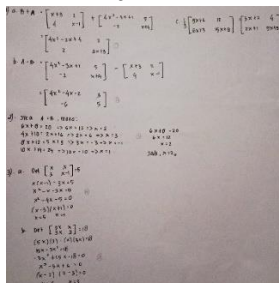


Figure 4. Results of answers to MF matrix questions

The test and interview results of subject MF showed that he had adequate understanding in solving problems related to matrix material. MF can perform basic operations such as addition, subtraction, and multiplication of matrices accurately and in a structured manner. He also showed the ability to determine the value of variables in matrix form, and can solve

problems involving factoring in matrix determinants correctly. This shows that MF has a fairly good mastery of the concepts and procedures in matrix material, both in terms of calculation and understanding of basic concepts.

However, on the other hand, MF had difficulty when dealing with algebraic problems. He was not able to simplify algebraic forms correctly, especially in problems involving addition, subtraction, and multiplication operations. When asked to determine the value in the form of a one-variable equation, MF also seemed confused in choosing the appropriate solution steps. In addition, MF also had difficulty in factoring algebraic forms, which showed that MF lacked mastery of the basic concepts of algebra. MF's difficulties were not only in the basic concepts of algebra, but were also seen when solving problems using the elimination and substitution methods. Both in algebraic problems and in matrix form, MF could not solve them. This shows that MF does not fully understand the logical steps of the method. Although MF seemed to have mastered the material on matrices in general, the lack of mastery of basic algebraic concepts was an obstacle in solving problems that required integration between the two materials.

Based on the results of the study above, it is said that students experience varying difficulties in solving algebra problems, and these difficulties have direct implications for their understanding of solving problems related to matrix material. This finding is consistent with previous studies showing that basic skills in algebra are an important prerequisite for understanding advanced concepts such as matrices (Istikaanah & Wardayani, 2022) . In line with research (Richsan et al., 2021) also found that students' difficulties in basic algebraic concepts such as factoring and linear equation forms, are often caused by weak mastery of prerequisite concepts since high school level which has an impact on their knowledge in college. Analysis of the subjects LF, NN, and MF shows that differences in mastery of algebraic concepts have an impact on their ability to transfer knowledge into the form of solving matrix problems.

Subject LF showed relatively good mastery of matrix concepts, but faced significant difficulties in solving algebra problems, especially in factorization problems and methods for solving linear equation systems. This shows that although LF can understand the structure of matrices and their calculation procedures, limited understanding of basic algebraic concepts is an obstacle in solving matrix problems that require the integration of algebraic concepts. As explained by (Giriansyah & Pujiastuti, 2021) , conceptual understanding is an important basis in learning mathematics because it is the foundation for solving more complex problems. This view is supported by research (Noviani et al., 2022) which emphasizes the importance of instilling meaning in algebraic operations through a contextual approach. In contrast, subject NN showed that he had better mastery of algebraic material, but was weak in solving matrix problems.

This condition confirms that good mastery of algebra does not necessarily guarantee an understanding of matrix material, if it is not supported by a specific understanding of the properties and basic operations of matrices. This is in accordance with the findings of (Farida & Indah, 2021) , which state that learning difficulties in matrix material are often caused by differences in representation and abstraction of concepts that are not found in basic algebra. Research (Ayu et al., 2024) added that a common cause of students' errors in understanding matrix concepts is the lack of connection between algebra and matrix learning during the learning process. In addition, abstract thinking skills and conceptual flexibility are needed to understand changes in context between algebra and matrices (Azmi, 2025) .

The third subject, MF, showed good mastery of matrices but had difficulty solving algebra problems. Like subject LF, MF had difficulty in simplifying algebraic forms and solving one-variable equations. This indicates a weak procedural understanding of algebraic material. Research by (Purwanti & Pujiastuti, 2020) also found that students who do not have a deep understanding of procedures in algebra tend to have difficulty in compiling problem-solving steps, especially when faced with problems that require sequential logic such as elimination or substitution systems. This is also reinforced by research by (Haniah & Senjayawati, 2023) , which found that algebraic difficulties in early semester students stem

more from the mechanistic processes that were previously taught without involving deep understanding. As stated by (Sari et al., 2020) found that students who develop a balanced procedural and conceptual understanding are better able to solve problems on materials such as algebra and matrices. In the context of this study, students who only have one of the two show suboptimal performance in solving problems that require integration of both aspects, such as in matrix material.

Difficulty in using the elimination and substitution methods is also a common pattern in all three subjects. In both algebraic and matrix contexts, these methods seem to cause confusion in determining the logical steps of the solution. This reflects the findings of research (Lestari, 2021) which shows that students often do not understand the logical structure in the elimination method due to their weak mastery of basic operations and understanding of the relations between variables. In line with research (Nawafilah, 2019) which states that the majority of students make mistakes in using the elimination method because they do not understand the correspondence between elements of the system of equations and positions in matrices. This condition has an impact on their understanding of the system of linear equations, which is an important element in matrix learning. These findings have important implications for learning planning. Lecturers need to design learning that integrates algebraic concepts into solving matrix problems explicitly. A problem-based learning (PBL) approach, for example, can help students develop a deeper understanding of the relationships between mathematical concepts. By providing opportunities for students to formulate and modify their own questions, they can better understand the structure and meaning of the concepts being studied

CONCLUSION

The results of the study indicate that students still experience various difficulties in solving algebra problems, especially in the aspects of basic operations, factoring, solving one-variable equations, and applying the elimination and substitution methods. This problem significantly affects their ability to understand matrix concepts, which basically depend heavily on the mastery of algebraic material. This is a strong correlation between algebraic ability and understanding of matrix material. Therefore, it is recommended that lecturers or mathematics teachers pay more attention to the mastery of basic algebraic concepts through contextual and problem-based learning methods, so that students can master these concepts with their application in advanced materials. In addition, periodic learning evaluation is very important to identify student difficulties early on, as well as provide guidance or remedial programs for those who need them. The findings of this study are expected to be the basis for designing more effective learning strategies to improve students' conceptual understanding in college-level mathematics

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